# (12) UK Patent Application (19) GB (11) 2 107 448 A

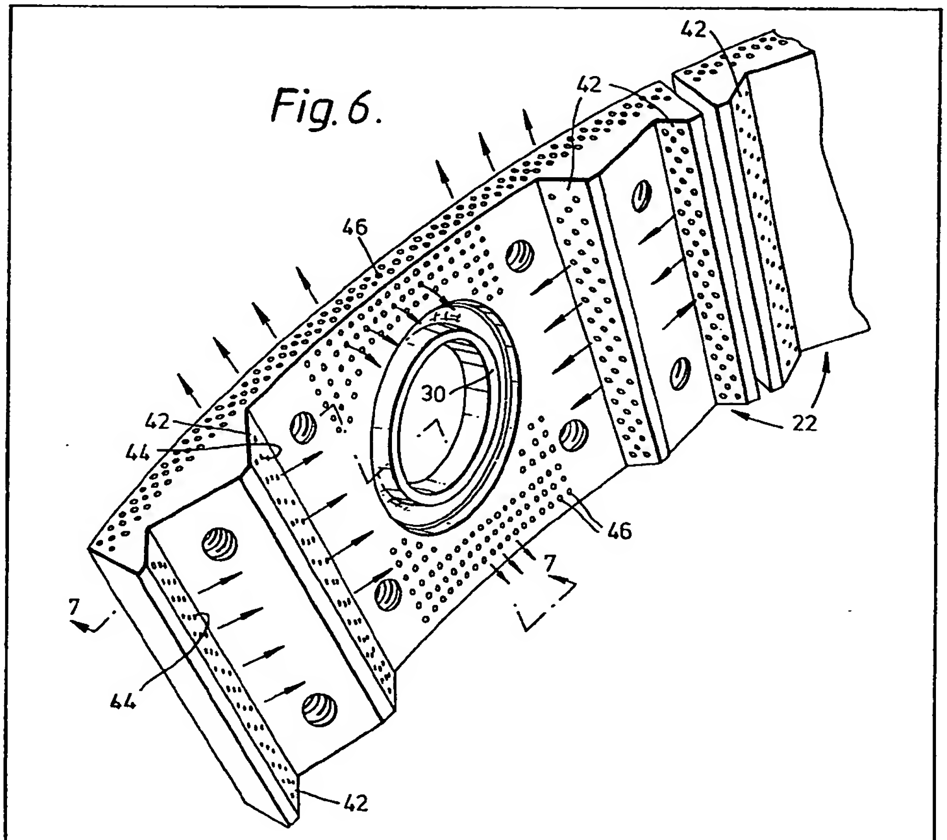
(21) Application No 8033850
(22) Date of filing 21 Oct 1980
(43) Application published 27 Apr 1983
(51) INT CL[3] F23R 3/04
(52) Domestic classification F4T 101 AK U1S 1987 F4T
(56) Documents cited GB 1315856 GB 0877823 GB A 2044912
(58) Field of search F4T

(71) Applicants
Rolls-Royce Limited, (Great Britain), 65 Buckingham Gate, London SW1E 6AT.
(72) Inventors
Richard Barrie Smart
(74) Agents
G T Kelvie, Rolls-Royce Limited, Company Patents and Licensing Dept, P O Box 31, Moor Lane, Derby DE2 8BJ.

## (54) Gas turbine engine combustion chambers

(57) In order to reduce undesirable emissions from a gas turbine engine combustion chamber, the upstream wall of the combustion chamber comprises segments (22) each having an upstream wall portion and a downstream wall portion which between them define a space arranged to receive a flow of air. Each segment (22) has a central aperture (30) and a pair of facets (42) on the downstream wall portion arranged on each side of the central aperture (30), and each facet (42) has associated apertures for the through-flow of cooling air over the downstream face of the downstream wall portion. Each segment (22) has a swirler assembly positioned in and coaxially around the central aperture (30) between the upstream and downstream wall portions to form a radial air passage between the chamber and the central aperture (30). A fuel burner is positioned in the central aperture (30) upstream of the swirler assembly, the fuel burner introducing a fuel/air mixture into the combustion chamber through the central aperture (30).

Fig. 6.




The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

GB 2 107 448 A

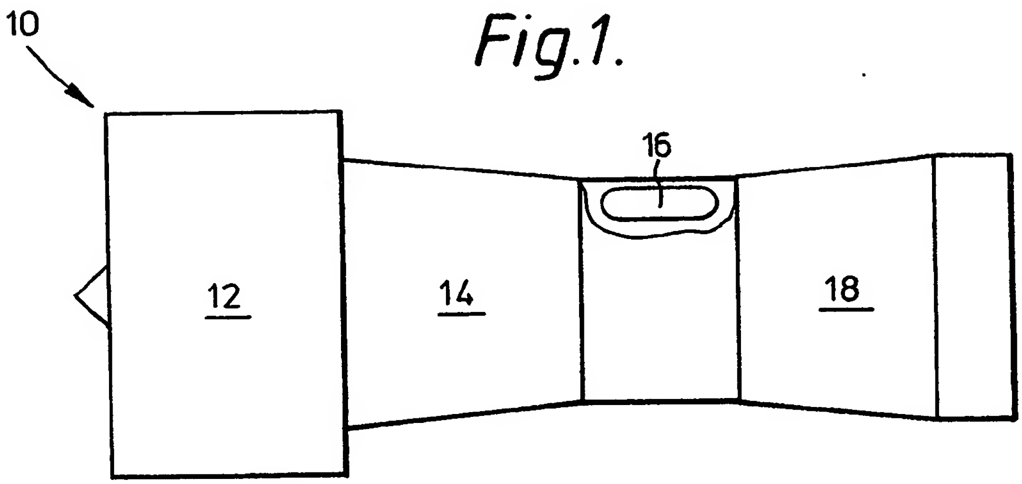



Fig.1.

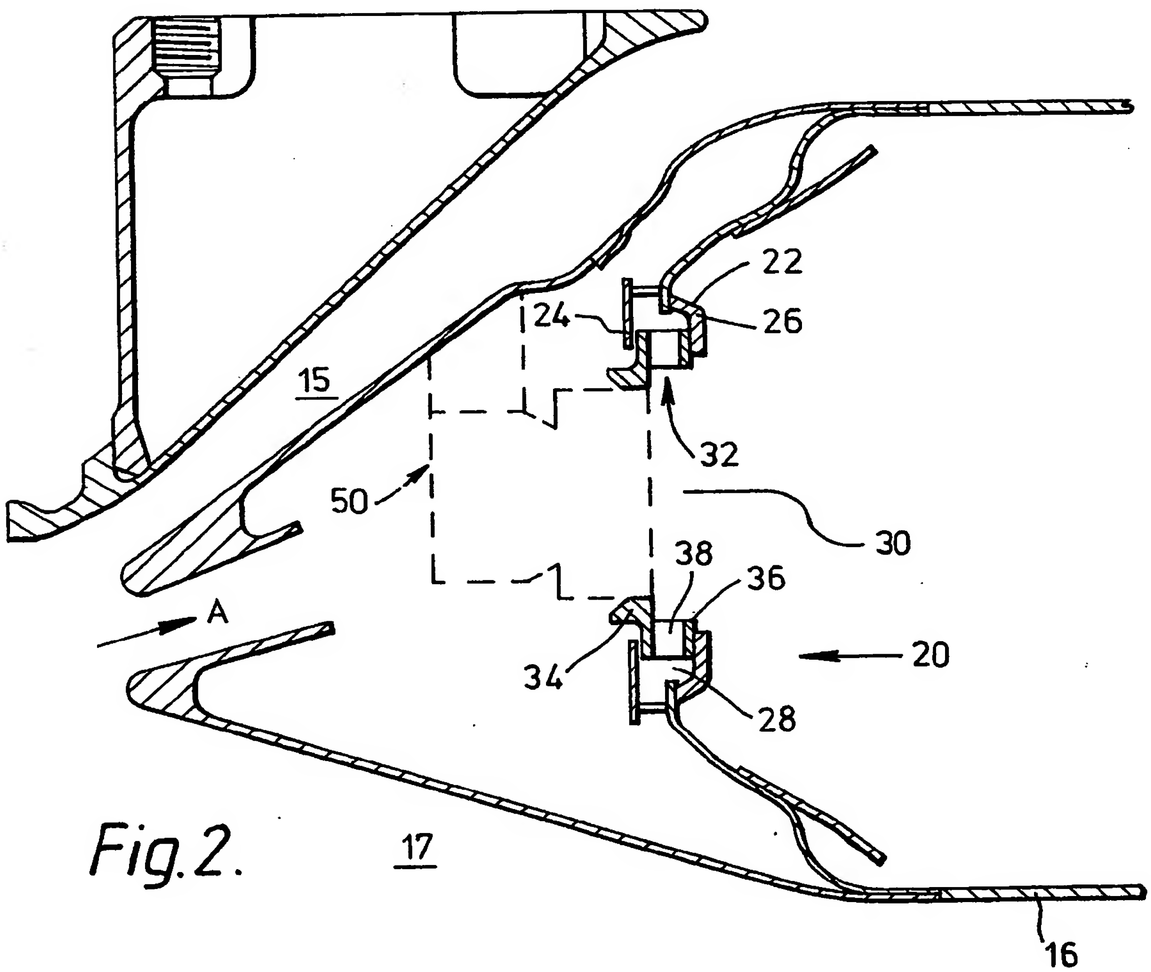



Fig.2.

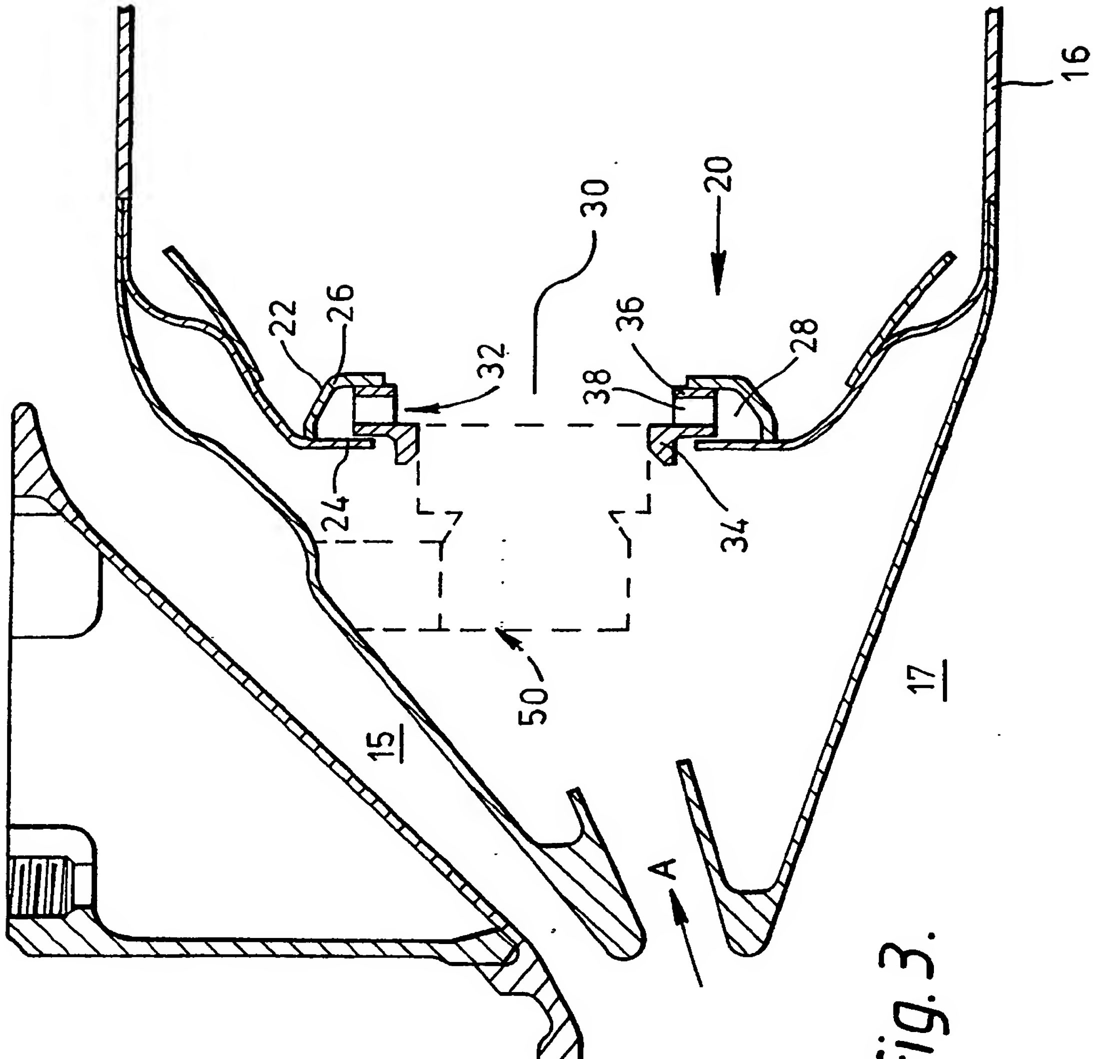



Fig. 3.

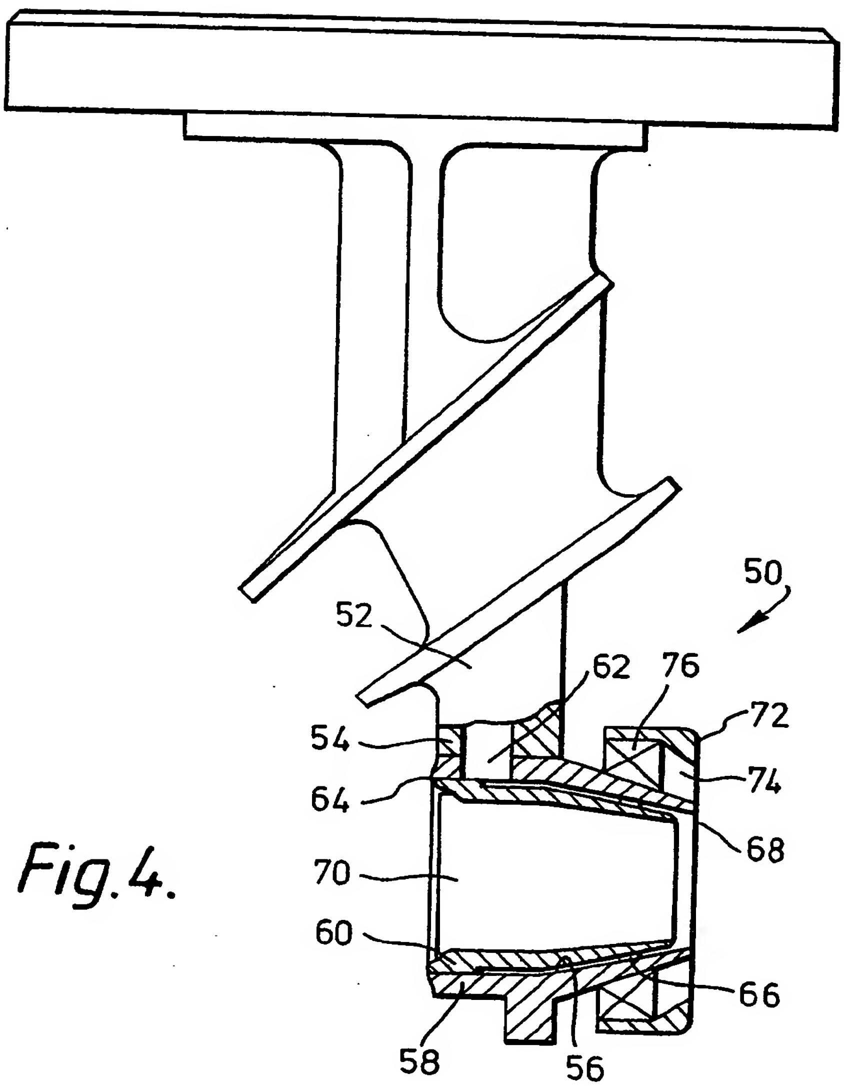



Fig.4.

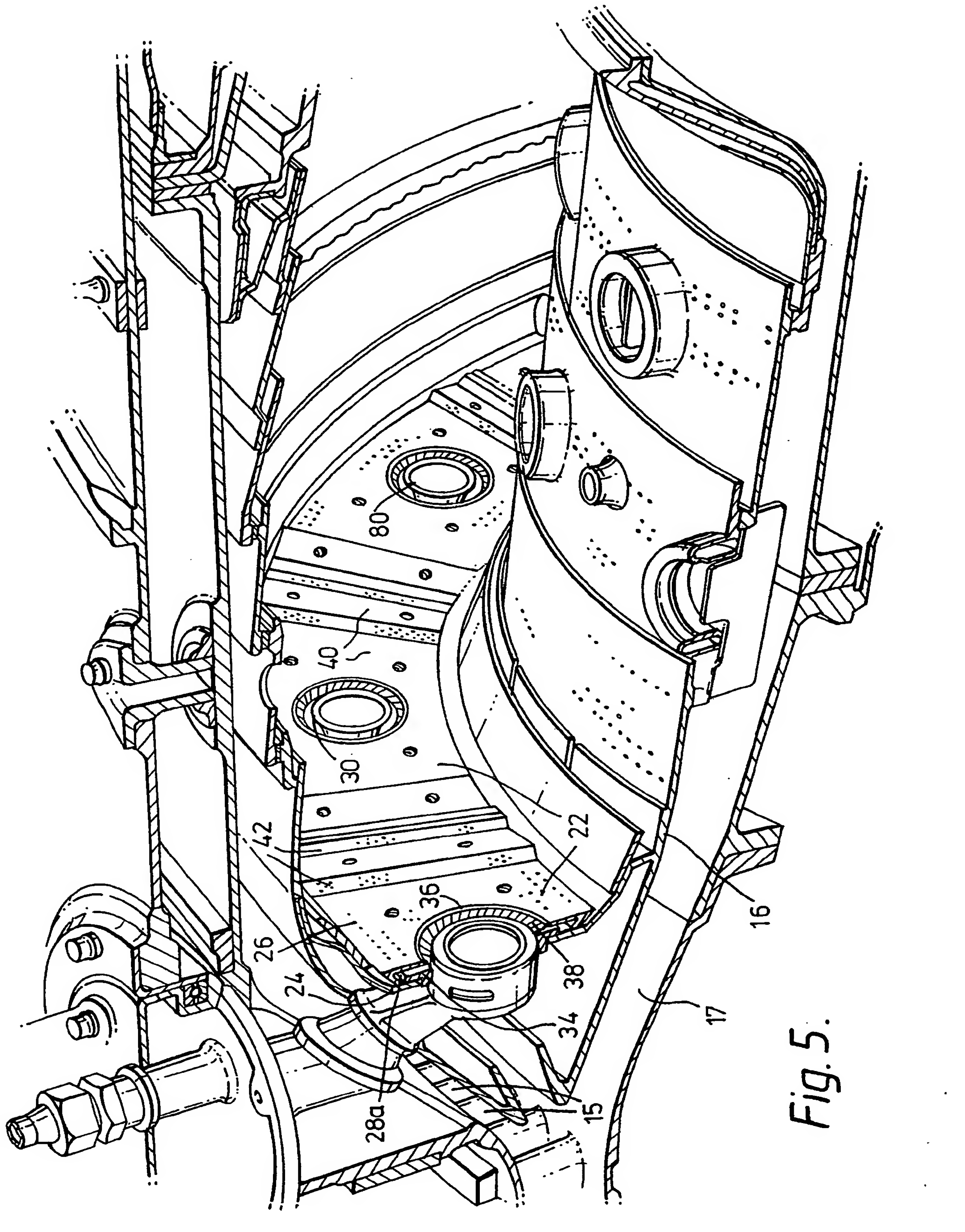



Fig. 5.

Fig. 6.

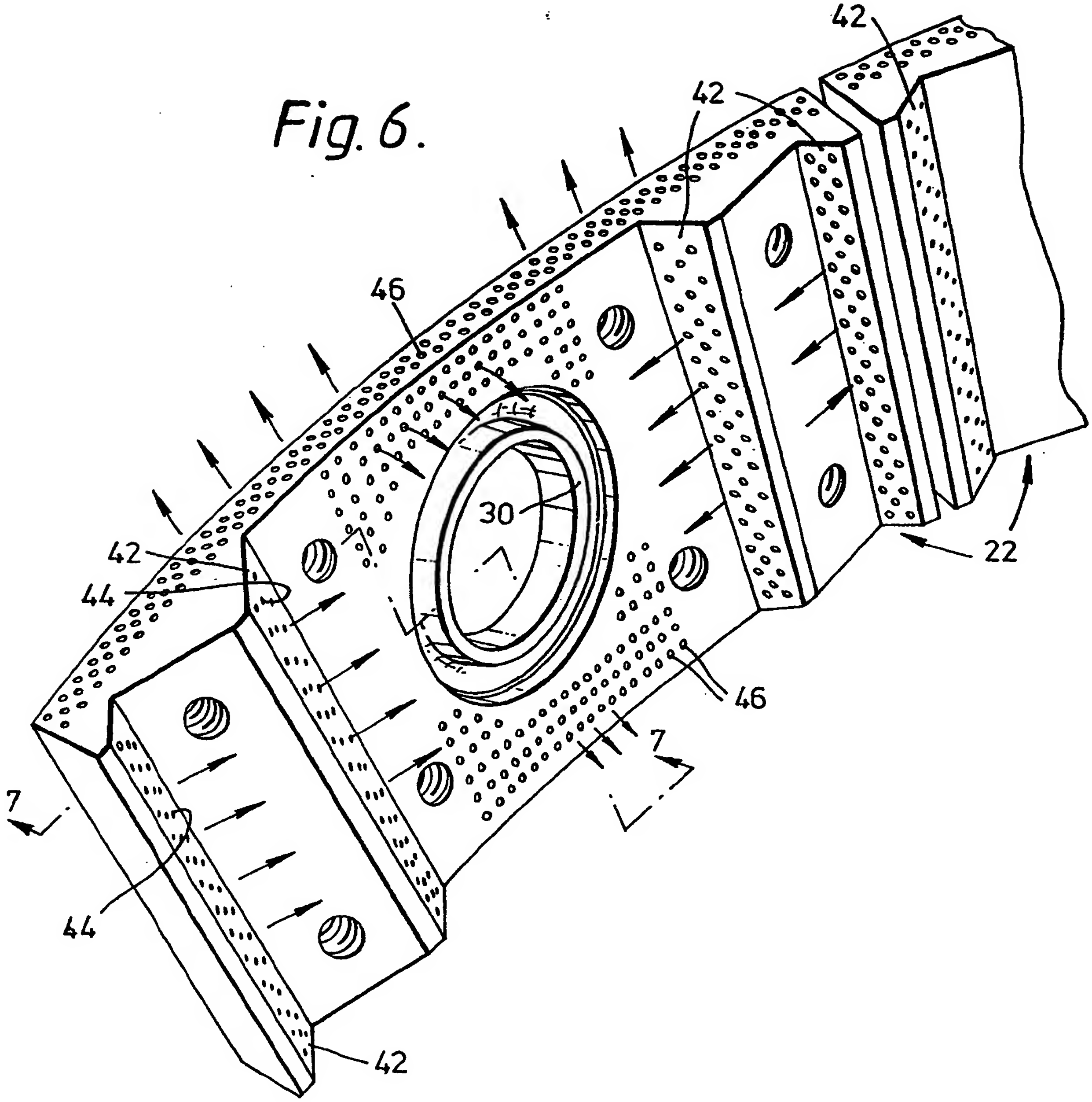
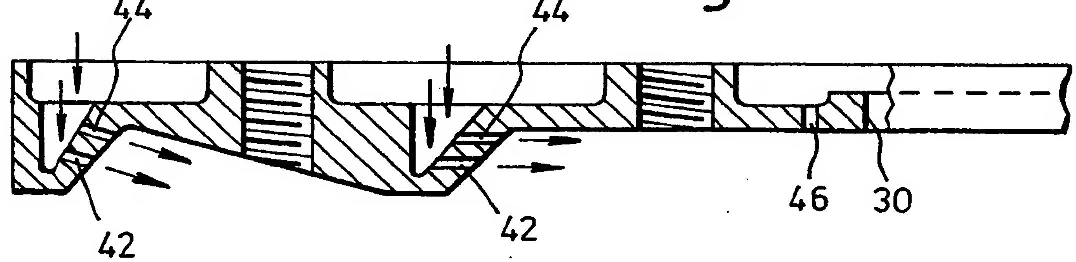



Fig. 7.



SPECIFICATION

**Improvements in or relating to gas turbine engine combustion chambers**

The present invention relates to combustion chambers for gas turbine engines and is particularly concerned with reducing undesirable emissions from such combustion chambers.

Increasing legislation in recent years has required the amounts of undesirable emissions from gas turbine engines to be controlled.

The present invention seeks to provide a form of construction for the combustion chamber of a gas turbine engine which will produce a more uniform mixture of fuel and air in the primary zone of the combustion chamber so that the emissions of unburnt hydrocarbons (UHC) and carbon monoxide (CO) at engine idle speeds and the emission of smoke at high engine speeds are reduced.

According to the present invention there is provided a gas turbine engine combustion chamber having an upstream wall comprising an upstream wall portion and a downstream wall portion, the upstream and downstream wall portions being attached one to the other and defining therebetween a chamber arranged to receive a flow of primary and cooling air through a plurality of holes in the upstream wall portion, the downstream wall portion having means to direct a film of cooling air from said chamber over to the downstream face of the downstream wall portion, the upstream wall having a plurality of apertures therein and each said aperture having a coaxial radial swirler assembly arranged circumferentially around each aperture between the upstream and downstream wall portions, the radial swirler assembly providing a passage for the flow of primary air from said chamber into the combustion chamber, and a fuel burner being positioned coaxially inside said aperture upstream of the radial swirler assembly, the fuel burner introducing a fuel/air mixture into the combustion chamber through the said aperture.

The downstream face of the downstream wall portion comprises a plurality of facets set at an angle to the downstream face of the downstream wall portion, each said facet having a plurality of apertures for the through flow of cooling air from said chamber to the said downstream face of the downstream wall portion.

The downstream wall portion comprises a plurality of segments, adjacent segments being in abutting relationship with one another, each said segment being provided with at least one said aperture placed centrally in the said segment, and each said segment includes at least two of said facets and associated apertures, the two facets being opposed to each other and positioned one on each side of the said aperture, the cooling air from the apertures in one facet being arranged to flow in opposition to the cooling air flowing from the apertures in the other facet.

Each said segment may have a pair of facets on each side of said aperture.

The apertures in the or each facet are formed parallel to the downstream face of the downstream wall portion adjacent the said facet.

The fuel burner may comprise an inner and a coaxial outer cylindrical wall one joined to the other at the upstream end and defining between them an annular fuel passage which has a plurality of swirl slots disposed between the two coaxial cylindrical walls near the downstream end to impart a swirl to the fuel as it flows in a dowsntream direction to an open downstream end, a central air passage is formed coaxially through the inner cylindrical wall for the through flow of unswirled primary air in a downstream direction into the said aperture, an annular air passage is formed between a coaxial shroud positioned around and spaced from the outer cylindrical wall by a plurality of swirl vanes extending therebetween, said swirl vanes impart a swirl to the primary air flowing through said annular air passage into said aperture, the fuel emerging from the downstream end of said annular fuel passage into said central air passage flows with the unswirled primary air into said aperture where the fuel is atomised and mixed with the swirled primary air from the said annular air passage and swirled primary air from the said chamber of the said upstream wall.

The combustion chamber is of the can type, the can-annular type or the annular type.

The invention will now be more particularly described with reference to the accompanying drawings in which:

*Figure 1* is a diagrammatic view of a gas turbine engine including one form of combustion chamber according to the present invention,

*Figure 2* is a view to an enlarged scale showing in mor detail the upstream end of the combustion chamber shown in Figure 1.

*Figure 3* is a view to an enlarged scale showing in more detail another arrangement for the upstream end of the combustion chamber as shown in Figure 1,

*Figure 4* is a view of the preferred fuel burner to be used in the combustion chamber,

*Figure 5* is a perspective view of part of an annular combustion chamber according to the invention having airspray fuel burners,

*Figure 6* is a perspective view and a segment of the upstream wall of the combustion chamber shown in Figure 1 and,

*Figure 7* is a section on line 7-7 in Figure 6.

Referring to the figures, a gas turbine engine 10 comprises in flow series a fan 12, a compressor 14, an annular combustion chamber 16 and a turbine 18, the fan 12 being driven by one section of the turbine 18 and the compressor 14 being driven by the remaining section of the turbine 18 as shown in Figure 1.

Referring to Figures 2, 3, 5, 6 and 7, the annular combustion chamber 16 has annular passages 15 and 17 positioned radially outside and inside respectively of the combustion chamber 16 for the flow of cooling air around the combustion chamber 16.

The combustion chamber 16 has an upstream wall 20 as disclosed in UK patent application (7910157) 2044912, which comprises a plurality of segments 22

arranged in abutting end-to-end relationship, each segment 22 comprising an upstream wall portion 24 and a downstream wall portion 26, the two wall portions 24 and 26 being spaced apart to form a chamber 28 which receives a flow of air from the compressor 14 through holes (not shown) in the upstream wall portion 24. Each segment 22 has a central aperture 30 to allow a fuel/air mixture from each fuel burner 50 to enter the combustion chamber 16, and each segment 22 has a swirler assembly 32 positioned in and coaxially around the central aperture 30 between the upstream and downstream wall portions 24 and 26 to form a radial air passage between chamber 28 and central aperture 30. The swirler assembly 32 comprises two axially spaced annular walls 34 and 36 with a plurality of swirler blades 38 positioned therebetween.

The downstream wall portion 26 has a downstream face 40 and pairs of facets 42, one pair of facets 42 being arranged on each side of the central aperture 30, and each pair being opposed to each other and being inclined at an angle to the adjacent part of the downstream face 40. Each facet 42 is produced with 3 rows of apertures 44 the axes of which are parallel to the adjacent part of the downstream face 40. Further apertures 46 are provided in the downstream face 40 around central aperture 30 and on the inboard and outboard faces of each segment 22.

A fuel burner 50 is positioned in the central aperture 30 upstream of the swirler assembly 32 as shown in Figures 2 and 3 by the broken lines.

Figure 4 shows a fuel burner 50 comprising a holder 52 having a passage 54 drilled in its stem for the flow of fuel to an annular fuel passage 56 formed between two coaxial cylindrical walls 58 and 60 through aperture 62 in the cylindrical wall 58. The cylindrical walls 58 and 60 are joined together at the upstream end 64 and have a number of swirl slots 66 positioned therebetween in the annular passage 56 near the downstream end 68.

A central passage 70 is formed coaxially through cylindrical wall 60 for the flow of primary air from the upstream end to the downstream end and into combustion chamber 16.

A coaxial shroud 72 is positioned around the downstream end 68 of the cylindrical wall 58 and forms an annular passage 74 for the flow of further primary air, and swirl blades 76 are positioned in the annular passage 74 and extend between the cylindrical wall 58 and shroud 72.

Figure 5 shows a perspective view of an annular combustion chamber having airspray fuel burners 80.

In operation some of the air delivered from the compressor 14 is used to cool the combustion chamber 16 through annular passages 15 and 17, the remainder being used in the combustion process is supplied in a downstream direction as shown by arrow A in Figures 2 and 3 to the combustion chamber 16.

Some of the air supplied to the combustion chamber 16 enters the chamber 28 formed between the upstream and downstream wall portions of the upstream wall 20 through apertures (not shown) in the upstream wall portion 24. Cooling air is supplied from chamber 28 through the apertures (not shown) in the facets 42 to form a film of cooling air over the downstream face 40 of the downstream wall portion 26. Further cooling air flows through apertures in the downstream face 40 and inboard and outboard faces to add to the cooling effect. Primary air is supplied from chamber 28 to the central aperture 30 through the swirler assembly 32, where a swirling motion is imparted to the primary air by swirl blades 38. The remainder of the air supplied to the combustion chamber 16 flows through the fuel burner 50 into the central aperture 30 of the upstream wall 20 before entering the combustion chamber 16.

Fuel is supplied to the fuel burner 50 through the passage 54 in the holder 52 into the annular passage 56 through the aperture 62 in cylindrical wall 58 where it flows in a downstream direction and is swirled by a number of swirl slots 66 positioned between the cylindrical walls 58 and 60 which define the annular passage 56 before the fuel emerges from the downstream end 68 of the annular passage 56 into the central passage 70. Unswirled primary air is supplied through the central aperture 70 defined by the cylindrical wall 60 and mixes with the swirling fuel emerging from the annular passage 56 and carries it in a downstream direction where it enters central aperture 30 and is atomised by and mixed with swirling primary air supplied through the annular passage 74 defined by the atomised and cylindrical wall 58 and the shroud 72 and swirling primary air supplied through the swirler assembly 32 from chamber 28 in the upstream wall 20.

Although the invention is described with reference to an air atomising fuel burner, the invention may be applied with other types of fuel burners, the air atomising fuel burner given lower emission levels than other types of fuel burners used.

CLAIMS

1. A gas turbine engine combustion chamber having an upstream wall comprising an upstream wall portion and a downstream wall portion, the upstream and downstream wall portions being attached one to the other and defining therebetween a chamber arranged to receive a flow of primary and cooling air through a plurality of holes in the upstream wall portion, the downstream wall portion having means to direct a film of cooling air from said chamber over the downstream face of the downstream wall portion, the upstream wall having a plurality of apertures therein and each said aperture having a coaxial radial swirler assembly arranged circumferentially around each aperture between the upstream and downstream wall portions the radial swirler assembly providing a passage for the flow of primary air from the chamber into the combustion chamber, and a fuel burner being positioned coaxially inside the said aperture upstream of the radial swirler assembly, the fuel burner introducing a fuel/air mixture into the combustion chamber through the said aperture.

2. A combustion chamber as claimed in claim 1 in which the means to direct a flow of cooling air

from said chamber over the downstream face of the downstream wall portion comprises a plurality of facets set at an angle to the downstream face of the downstream wall portion, each said facet having a plurality of apertures for the through flow of cooling air from said chamber to the said downstream face of the downstream wall portion.

3. A combustion chamber as claimed in claim 2 in which the downstream wall portion comprises a plurality of segments, adjacent segments being in abutting relationship with one another, each said segment being provided with at least one said aperture in the upstream wall placed centrally in the said segment, and each said segment includes at least two of said facets and associated apertures, the two facets being opposed to each other and positioned one on each side of the said aperture, the cooling air from the apertures in one facet are arranged to flow in oppsition to the cooling air flowing from the apertures in the other facet.

4. A combustion chamber as claimed in claim 3 in which each said segment has a pair of facets on each side of said aperture, the cooling air from the apertures in one pair of facets being arranged to flow in opposition to the cooling air flowing from the apertures in the other pair of facets.

5. A combustion chamber as claimed in any one of the preceding claims in which the apertures in the or each facet are formed parallel to the downstream face of the downstream wall portion adjacent the said facet.

6. A combustion chamber as claimed in any one of the preceding claims in which the fuel burner comprises an inner and an outer cylindrical wall, the cylindrical walls being joined one to the other at the upstream end and defining between them an annular fuel passage which has a plurality of swirl slots disposed between the two coaxial cylindrical walls near the downstream end to impart a swirl to the fuel as it flows in a downstream direction to an open downstream end, a central air passage is formed through the inner cylindrical wall for the through flow of unswirled primary air in a downstream direction into the said aperture, an annular air passage is formed between a coaxial shroud positioned around and spaced from the outer cylindrical wall by a plurality of swirl vanes extending therebetween, said swirl vanes impart a swirl to the primary air flowing through said annular air passage into said aperture, the fuel emerging from the downstream end of the said annular fuel passage into said central air passage flows with the unswirled primary air into said aperture where the fuel is atomised and mixed with the swirled primary air from the said annular air passage and swirled primary air from the said chamber of the said upstream wall.

7. A combustion chamber as claimed in any one of the preceding claims in which the combustion chamber is of the can type, the can-annular type, on the annular type.

8. A gas turbine engine combustion chamber constructed and arranged substantially as herein described with reference to the accompanying drawings.

Printed for Her Majesty's Stationery Office, by Croydon Printing Company Limited, Croydon, Surrey, 1983.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.